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(58) Field of search
G1N

(54) Encoder apparatus

(57) Encoder apparatus is provided comprising an element 10 having spaced magnetic zones 4 thereon, and a detector 6 spaced from the element for detecting relative movement between the magnetic zones and the detector. The relative movement between the magnetic zones and the detector may be rotary or linear, although the distance between the element and the detector remains substantially fixed. A preferred embodiment comprises several rows of spaced magnetic zones co-operable with several detectors, the detectors being fixed, whereby to provide positional, directional and speed information relating to the element. In a rotary embodiment the element comprises a disc or drum.

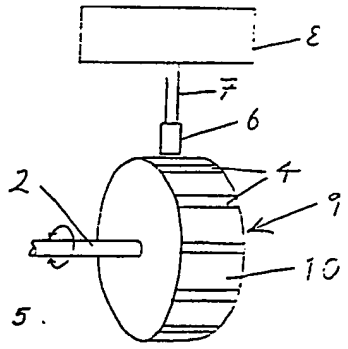

Fig. 5.

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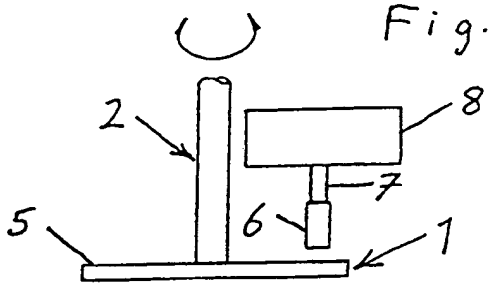
Fig. 1.



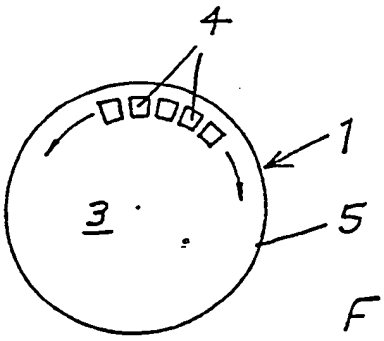


Fig. 2.

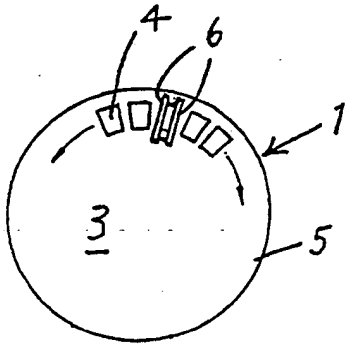
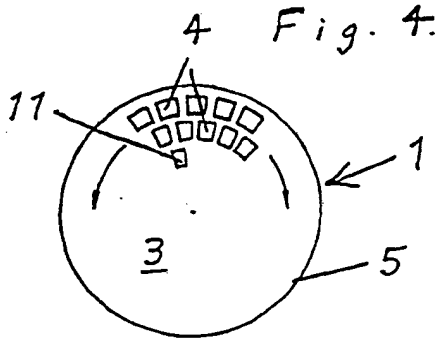


Fig. 3.

Fig. 4.



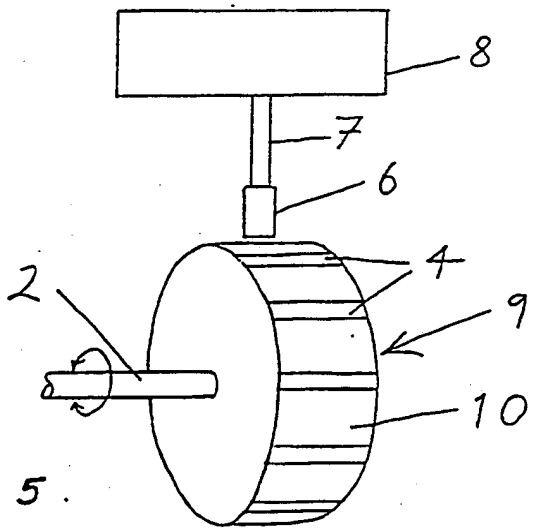
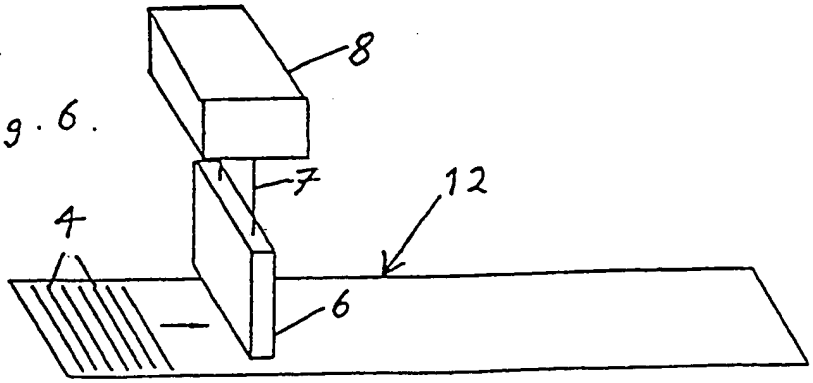


Fig. 5.

Fig. 6.



ENCODER APPARATUS

This invention concerns encoder apparatus of the type used to detect and measure in some way relative movement between an element and a detector.

An encoder already known is an optical encoder which, in one embodiment, comprises a light emitting diode, a detector spaced from the diode to detect light from the diode, and an intermediate slotted element, usually a rotatable disc. This arrangement works by movement of the element causing the slots to move between the diode and the detector, thus alternately allowing and restricting passage of light between the diode and the detector and providing information as to relative movement between the slots and the diode and detector.

It will be appreciated from the above that such a system requires three constituent parts to enable it to function. Furthermore, such a system will not operate well in a dirty atmosphere or where deposits of grime are likely to form on the diode or the detector, as either of these circumstances will prevent efficient transmittal of the light from the diode to the detector. This system is also relatively costly to set up and requires space to be provided on two sides of the movable element for provision of the diode and the detector. Such an arrangement as described may not always be suitable, for reasons of space, and thus may have to be located remotely from the equipment whose movement is being monitored whilst being connected thereto for corresponding movement, this arrangement tending to lead to inaccuracy of measurement of the movement.

There is thus a need for simpler, more versatile and space efficient and cheaper encoder apparatus.

According to the present invention there is provided encoder apparatus comprising an element having spaced magnetic zones thereon, and a detector spaced from the element for detecting relative movement between the

magnetic zones and the detector.

Preferably the spacing between the detector and the element remains substantially constant during the relative movement between the magnetic zones and the detector. A preferred arrangement would have the detector mounted in a fixed position and remaining substantially still during the relative movement. The relative movement may be rotary, wherein the element may comprise a rotating surface which may be formed on a disc or drum whereby the magnetic elements may be positioned regularly therearound. Alternatively the relative movement may be linear and the magnetic zones may be positioned regularly along the length of a linear said element, for example upon a surface thereof. With such a rotary or linear arrangement, the detector, which may be a magnetoresistive detector, is preferably positioned a short distance, for example of the order of not more than 5mm from the element, this short distance remaining substantially constant during operation of the apparatus.

The magnetic zones may be equally spaced from one another in the direction of movement being measured, and each said zone may comprise a discrete strip which may be formed by screen printing a magnetic ink on the element. Such a magnetic ink may conveniently comprise gamma ferric oxide particles. Alternatively, the magnetic zones may comprise magnetised, or unmagnetised zones on a magnetic film.

The apparatus may be adapted to detect the speed of the relative movement, and/or may be adapted to detect the direction of the relative movement. An embodiment adapted to detect the direction of the relative movement may comprise two rows of magnetised zones staggered in relation to one another, and may comprise a detector for each row. Conveniently, the magnetic zones of the respective rows may be 90^{o} out of phase in order to provide the directional information. Alternatively, an

embodiment adapted to detect the direction of the relative movement may comprise a single row of magnetic zones and at least two detectors. The at least two detectors may be spaced from each other along the row of magnetic zones, preferably by a distance unequal to the spacing of the zones, whereby to provide information as to the direction of relative movement.

The apparatus may also be used to detect the relative positions of the element and the detector or detectors and the element may comprise a third row of zones together with a third detector for this purpose. The third row may comprise at least one "zero" zone adapted to indicate at least one zero position on the element. Each said "zero" zone may be used to reset processing means, which may be electronic, used to process signals from the detectors which correspond to movement relative to the magnetic zones. Alternatively, a given position on the element may be uniquely indicated by a combination of the magnetic zones detected by the detector or dectectors at that position. In this embodiment the number of rows of magnetic zones required will depend upon the degree of resolution of position of the element which is required.

The concentration of the zones in the direction of movement maybe such as to allow resolution of the position of the element, where measured, to substantially 0.33mm or more for which the concentration of zones may be substantially 25 per centimetre or less.

It will be appreciated that the apparatus of the present invention may be part of or attached to any other apparatus on which it is desired to measure position, direction of movement and/or speed of a movable part thereof. When used in rotary or linear form, the apparatus may have applications in robotic control, pick and place, and factory automation systems, for example warehouse stacking and the like. It will be particularly

noted by those skilled in the art that the apparatus of the present invention enables any moving element of a piece of equipment, whether it be solid or hollow, to be monitored as to movement merely by provision of magnetic zones on a surface of that element and a detector in proximity thereto.

The apparatus of the present invention will now be more particularly described, with reference to a preferred embodiment thereof, as shown in the accompanying schematic drawings in which:-

Figure 1 is a side view of rotary disc encoder apparatus according to a first embodiment of the present invention,

Figure 2 is a plan view of the disc of the apparatus of Figure 1,

Figure 3 is a plan view of the disc of Figure 2 and a pair of detectors.

Figure 4 is a plan view of a similar disc comprising three rows of magnetic zones.

Figure 5 is a perspective view of drum encoder apparatus according to a second embodiment of the present invention, and

Figure 6 is a perspective view of linear encoder apparatus according to a third embodiment of the present invention.

Referring to Figures 1 to 5, the apparatus comprises a movable element forming a disc 1 or drum 9 rotatable on a shaft 2. The disc 1 has (referring to Figure 2) a top surface 3 comprising a row of discrete magnetic zones 4 disposed around same near a peripheral edge 5 thereof. Referring to Figure 5, the drum 9 has a peripheral surface 10 comprising a row of equi spaced magnetic zones 4 there around. Figure 4 shows a similar disc 1 to that shown in Figures 1 and 2, but having three rows of magnetic zones 4 spaced around a top surface 3 thereof. The magnetic zones 4 are formed by magnetising discrete

portions on a magnetic film adhered to the surface 3 of the disc 1. This method of forming the zones 4 allows high resolution of the position of the disc. It will be appreciated that no separate zones 4 are visible when looking at the surface of the disc when this method of forming the zones 4 is used.

A magnetoresistive detector 6 is positioned a small distance above the rotatable disc 1 and drum 9 and has electrical wires 7 extending therefrom to processing means 8.

In operation, the rotatable disc 1 or drum 9, which although shown attached to a rotatable shaft may be part of a rotatable component whose direction of travel, speed or position is to be measured, is caused to rotate whereby the row of magnetic zones 4 is caused to pass under the magnetoresistive detector 6. The passage of each magnetic zone 4 underneath the detector 6 will cause a resistance in the detector 6 to change whereby the rotation of the disc 1 or drum 9 may be detected. A single row of magnetic zones 4 on the disc or drum enables speed and/or relative position of same to be measured, but not absolute position or direction of rotation thereof, unless the row of zones 4 passes under two spaced detectors 6, as shown in Figure 3, which, when connected to processing means 8 may be used to provide directional information as to the disc rotation.

Figure 4 shows a disc 1, which when used in the apparatus of Figure 1, will allow speed and direction of rotation of the disc and absolute position thereof to be monitored. With this embodiment of the disc, three detectors 6 are used, one for each row of magnetic zones 4. Speed and relative position of the disc 1 may be monitored using either of the two outer rows of zones 4 and the processing means 8, and the direction of rotation of the disc 1 may be monitored by combining the information from the two outer rows 4, which are 90^{o} out

of phase with one another. If the absolute position of the disc 1 is required to be known, a single "zero position" zone 11 will be used, as shown, such that every time the "zero" zone 11 registers under its corresponding detector 6, the processing means 8 can be used to return any counters employed therein to a corresponding "zero" position. It will be appreciated that as many "zero" positions as desired may be provided on the disc 1 by providing a single "zero" zone 11 at each desired "zero position".

It will be appreciated that the method of operation of a linear encoder as shown in Figure 6 will employ similar arranged rows of magnetic zones 4, only disposed in a linear manner along an element 12 whose position and/or speed and/or direction of movement is to be monitored relative to one or more detectors.

From the foregoing it will be appreciated that the apparatus of the present invention provides a cheap, simple and reliable means of detecting relative movement between an element and a detector.

Claims

1. Encoder apparatus comprising an element having spaced magnetic zones thereon, and a detector spaced from the element for detecting relative movement between the magnetic zones and the detector.

2. Encoder apparatus according to claim 1, wherein the spacing between the detector and the element remains substantially constant during operation of the apparatus.

3. Encoder apparatus according to claim 1 or 2, wherein the relative movement between the magnetic zones and the detector is rotary.

4. Encoder apparatus according to claim 3, wherein the element comprises a rotatable surface.

5. Encoder apparatus according to claim 4, wherein the rotatable surface is a surface of a disc.

6. Encoder apparatus according to claim 4, wherein the rotatable surface is the peripheral surface of a drum.

7. Encoder apparatus according to claim 1 or 2, wherein the relative movement between the magnetic zones and the detector is linear.

8. Encoder apparatus according to any one of the preceding claims, wherein the zones are spaced regularly from one another in the direction of relative movement.

9. Encoder apparatus according to any one of the preceding claims, wherein the detector is mounted in fixed position.

10. Encoder apparatus according to any one of the preceding claims, wherein the detector is a magnetoresistive detector.

11. Encoder apparatus according to any one of the preceding claims, wherein the detector is spaced not more than 5mm from the element.

12. Encoder apparatus according to any one of the preceding claims, wherein each said zone comprises a discrete strip.

13. Encoder apparatus according to any one of the

preceding claims, wherein each said zone is formed by screen printing a magnetic ink on the element.

14. Encoder apparatus according to claim 13, wherein the magnetic ink comprises gamma ferric oxide particles.

15. Encoder apparatus according to any one of the preceding claims, wherein each said zone is formed on a continuous magnetic film by magnetising a portion thereof.

16. Encoder apparatus according to any one of the preceding claims, comprising means for indicating the speed of relative movement by assessing the rate of movement of the zones with respect to the detector.

17. Encoder apparatus according to any one of the preceding claims, adapted to detect the direction of the relative movement.

18. Encoder apparatus according to claim 17, wherein the apparatus comprises two rows of magnetic zones which are staggered with respect to one another, each row being co-operable with a detector.

19. Encoder apparatus according to claim 18, wherein the staggered rows of zones are 90^{o} out of phase with one another.

20. Encoder appratus according to claim 17, comprising a row of magnetic zones and at least two detectors cooperable therewith.

21. Encoder apparatus according to claim 20, wherein the at least two detectors are spaced from each other along the row of magnetic zones.

22. Encoder apparatus according to claim 21, wherein the spacing between the at least two detectors is unequal to the spacing of the magnetic zones.

23. Encoder apparatus according to any one of the preceding claims, adapted to detect the relative positions of the element and the detector or detectors.

24. Encoder apparatus according to claim 23, comprising a third row of at least one magnetic zone co-operable with a detector.

25. Encoder apparatus according to claim 23, wherein a given position on the element is uniquely indicated by a combination of magnetic zones disposed in different rows on the element.

26. Encoder apparatus according to any one of the preceding claims, wherein the concentration of zones in the direction of movement of the element is such as to allow resolution of the position of the element, where measured, to substantially 0.33mm or more.

27. Encoder apparatus according to claim 26, wherein the concentration of zones is substantially 25 per centimetre or less.

28. Encoder apparatus substantially as herein described with reference to the accompanying drawings.

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